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A BIOLOGICAL EVALUATION OF LAKE ALPINE BASIN, CALAVERAS RANGER DISTRICT, STANISLAUS NATIONAL FOREST

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ABSTRACT

Five campgrounds and two picnic areas in the Lake Alpine Basin were evaluated for pest problems which may affect resource management objectives for the sites. The major pests noted were annosus root disease, red fir dwarf mistletoe, the fir engraver, and the mountain pine beetle. Management alternatives including 1) no change in current management direction, 2) annosus root disease management, 3) dwarf mistletoe management, 4) hazardous tree reduction, 5) slash treatment, 6) control gophers, and 7) integration of treatments are discussed.

INTRODUCTION

At the request of Blaine Cornell, Forest Supervisor, Stanislaus National Forest, we conducted a biological evaluation of several recreation sites in the Lake Alpine Basin on July 16 and 17, 1984. The sites included the Silver Valley, Pine Marten, Backpackers, Lake Alpine, and Silvertip Campgrounds; and the Marmot and Chickaree Picnic Areas. We were accompanied during portions of the evaluation by Able Camarena and Aileen Palmer of the Calaveras Ranger District.

The resource management objective for the Lake Alpine Basin is to maintain the existing outdoor recreational experience by preventing loss of the tree cover and vegetation now present. The objectives of this evaluation were to identify existing and potential pest situations, to provide information on the expected future conditions of each site, and to provide the Calaveras Ranger District with pest management alternatives for planned Environmental Assessments.

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VEGETATION

Although variation exists, the vegetation in the 7,300 ft. elevation recreation area can be described as an overstory of mature-to-overmature red fir and lodgepole pine with an understory of red fir and lodgepole pine. Lodgepole pine becomes more common around meadows and adjacent to Alpine Lake. Associated conifers include some Jeffrey pines on drier sites (summer home tract area, one tree at Alpine Campground) and a few western white pines in the Marmot Picnic Area, in the stand between the Picnic Area and the Alpine Campground, and in Silvertip Campground. Some aspen occur in the vicinity of the summer home tract.

OBSERVATIONS

General observations made in the five campgrounds and two picnic areas are presented below. Site specific observations, by pest observed, are given for each of the seven areas in the Appendix.

Because of the relatively similar vegetation throughout the Lake Alpine Basin, the insects and diseases noted that are affecting or have the potential to affect management objectives for the Basin were similar. These included annosus root disease (Fomes annosus), red fir dwarf mistletoe (Arceuthobium abietinum f.sp. magnificae), the fir engraver (Scolytus ventralis), and the mountain pine beetle (Dendroctonus ponderosae).

Fomes annosus was commonly associated with red fir stumps throughout the Basin. It was difficult to find a red fir stump without conks of the pathogen. In some locations, at unit 11 in Silver Valley Campground for example, red fir saplings adjacent to the infected stump were being killed by the pathogen. Annosus root disease was not found on red firs in the Chickaree Picnic Area. The root disease was not found on any of the pine species in the Basin.

Red fir dwarf mistletoe occurred on overstory and understory trees at various intensities in the Basin. It was present on most overstory trees at Pine Martin, Silvertip, and Chickaree, but limited to specific, identifiable, infection centers at Silver Valley (vicinity of unit 7), Lake Alpine (vicinity of unit 10), and Marmot (vicinity of restroom). Dwarf mistletoe was not observed at Backpackers Campground. Infection in understory red firs was noted only at Pine Marten.

Fir engraver attacks, indicated by resin flow in upper boles, were common on living pole and sawtimber-sized red firs at Lake Alpine Campground. This type of attack normally indicates that the trees are under stress from other abiotic and/or biotic factors. The mountain pine beetle was associated with dying or recently dead overstory lodgepole pines at Silver Valley, Pine Marten, Lake Alpine and Silvertip.

Other, relatively minor, pests were noted. These included lodgepole pine dwarf mistletoe (Arceuthobium americanum) at Marmot; western gall rust (Endocronartium harknessii) on lodgepole pines at Silver Valley, Backpackers, Chickaree, Lake Alpine and Silvertip; Atropellis canker (Atropellis piniphila) on lodgepole pines at Marmot; lodgepole pine needlecast (Davisomycella montana) at Chickaree; yellow witches broom (Melampsorella caryophyllacearum) on red firs at Silver Valley, Backpackers, Silvertip, and Marmot; red ring rot (Phellinus pini) on red firs at Pine Martin; pine engraver (Ips emarginatus) on lodgepole pines at Chickaree; cytospora canker (Cytospora abietis) associated with dwarf mistletoe-infected red fir; roundheaded fir borer (Tetropium abietis) on red firs at Marmot; and gopher activity at Silvertip and Chickaree.

Three additional situations that will affect management objectives were noted. Potentially hazardous trees were not common, but were observed at Lake Alpine and Silvertip Campgrounds. Excess soil moisture at Silver Valley Campground, indicating a natural conversion of the site to a meadow, was stressing, and in some cases killing, red fir and lodgepole pine. Overstocking, i.e., dense thickets of red fir and lodgepole pine saplings and poles, occurred at Pine Martin and Silvertip Campgrounds.

MANAGEMENT ALTERNATIVES

The following management alternatives are generally applicable throughout the areas examined where a particular pest or group of pests was found. Biologies of pests are given in the Appendix.

1. No Change in Current Management Direction. Current levels of insect and disease activity will increase and contribute to site deterioration in the Lake Alpine Basin as stress factors, including annosus root disease, dwarf mistletoe, overstocking, and natural conversion to meadow, occur. Annosus root disease centers will continue to expand as long as there are root contacts with surrounding live red firs. The loss of red fir reproduction in these centers will decrease the amount of screening now present between some of the units. Trees with substantial annosus root and butt rot will have a high probability of failure, especially during severe winter storms. Centers additional to those identified may be present because of the difficulty of detecting F. annosus in live true firs. When hazardous trees are removed or when blow-down occurs, new annosus centers may be created by infection of freshly-cut stumps and wounds from spores of the fungus.

Dwarf mistletoe in red fir may increase as the proportion of red fir in the stands increases due to loss of lodgepole pine from stress factors and bark beetle attack. Dwarf mistletoe will infect understory red fir and lodgepole pine from the overstory source of infection to perpetuate the disease. Decay will develop in red fir dwarf mistletoe bole cankers and create potentially hazardous trees. Red fir in dense aggregations or red fir infected with root disease may become severely infected with dwarf mistletoe because of slow growth. Although presently at low levels, pine bark beetles and the fir engraver may contribute to an increase in mortality, particularly in trees weakened by root disease, dwarf mistletoe, and excess soil moisture.

2. Annosus Root Disease Management. The most effective control for annosus root disease is prevention. The probability of the formation of new centers, and the resulting adverse effects of the disease discussed in Alternative 1, can be reduced by the application of borax (sodium tetraborate decahydrate, EPA Reg. No. 1624-94) to all freshly-cut conifer stumps in the Lake Alpine Basin (see FSM 3205, 2331.33, R-5 Supplement No. 90). Over time, the vegetative composition will change in and around annosus centers with the percentage of red fir diminishing to be replaced by pines that are resistant to the strain of F. annosus on true fir.

Thinning active annosus centers may increase the tolerance of red fir to infection through increasing their rate of root regeneration and replacement and will minimize opportunities for root contact and subsequent spread. In addition, thinning will alleviate overstocking as a predisposing factor to insect attack.

3. Dwarf Mistletoe Management. Dwarf mistletoes can be controlled by eradication or by suppression. Eradication of dwarf mistletoe, which would involve removing infected hosts, is not viable in the areas examined.

Suppression of dwarf mistletoe involves minimizing the effects of the disease while tolerating a low level of infection. Various tactics are available for reducing the impact of dwarf mistletoe in recreation sites.

a. Remove infected overstory trees to protect regeneration. To prevent infection of understory trees, the infected overstory trees can be removed to eliminate the source of inoculum. The understory can then be thinned and pines pruned to remove dwarf mistletoe infections.

The stand at the overflow campground has had much of the overstory removed at some time in the past. This has halted the constant infection of the understory by dwarf mistletoe and it also released the understory. The stand now appears relatively healthy in comparison with the surrounding areas. Although it could benefit from thinning and follow-up dwarf mistletoe control work, it demonstrates that overstory removal is a viable alternative in portions of the local area.

b. Thinning. Thinning of infected stands will aid in maintaining optimum growth of residuals and reduce stress. Following release, lightly infected residuals may vertically outgrow the dwarf mistletoe. Infected trees growing at optimum stocking levels on good sites can achieve a rate of height growth greater than the rate of vertical spread of the dwarf mistletoe. Non-infected trees should be favored as leave trees. Red firs with bole infections should be considered for removal. Although bole infections are not serious from the standpoint of spreading dwarf mistletoe, they will deform the tree, lead to mortalilty in small trees, and may eventually result in open, decay-infected, bole cankers when the trees mature; a situation which is often hazardous in recreation areas. Keep in mind that all freshly cut stumps should with treated with borax to prevent invasion by F. annosus and green pine slash should be treated to prevent engraver beetle buildups.

In addition to minimizing the impact of dwarf mistletoe, thinning dense aggregations of conifers will minimize opportunities for root contact and subsequent spread of F. annosus. Increased tree vigor following thinning will also reduce the risk of bark beetle attack.

c. Encourage tree species diversity. A mix of non-susceptible species in infected stands provides a barrier to spread of dwarf mistletoe. Increasing, or at least maintaining, the present species mix should be encouraged.

d. Create buffer strips. The spread of dwarf mistletoe outward from the area of infestation can be minimized through the use of buffer strips. Susceptible species could be removed from the margins and the regeneration of non-susceptible species favored. The planting of western white pine and Jeffrey pine on suitable sites would create a buffer to dwarf mistletoe spread and increase tree species diversity.

4. Hazardous Tree Reduction. The hazardous tree identification and removal program in the Lake Alpine Basin appears to be well-managed and effective. Trees that are, or will become, potential hazards include those red firs with dead tops resulting from snow damage, firs with 6-class dwarf mistletoe ratings of 5 or 6, firs with dwarf mistletoe bole infections, and dead or dying lodgepole pines with beetle attacks.

In addition to hazardous tree removal, attempts to minimize formation of hazardous trees is necessary. This can include protecting residual trees from wounding during thinnings, and education of public users to reduce their impact.

5. Slash Treatment. Fresh pine slash caused by thinning, dwarf mistletoe control work, construction or winter storm breakage can be modified in a number of ways to make it unsuitable for pine engraver breeding. One approach to minimizing damage is to schedule slash-generating activities mostly in the late summer, fall, and early winter, when the beetles are not flying or the slash has a high probability of drying out before the beetles can complete their development. Green pine slash created during the spring and early summer should be treated to prevent the buildup of pine engraver populations. Because pine engravers can complete their development in about six weeks at Lake Alpine, treatment should be carried out soon after cutting to be effective. Some methods of slash treatment that might be acceptable in dispersed recreation areas would include lopping and scattering slash in sunny areas to speed its drying out, crushing or mashing slash with logging equipment to make it unsuitable for pine engraver breeding, or piling and burning the slash within six weeks of cutting. Broadcast burning the slash might work if it could be done while the slash was green without damaging the residual stand. The most acceptable methods of slash treatment in high-use recreation areas would probably be disposal by chipping or removal from the site.

6. Control Gophers. Some meadow areas of the Lake Alpine Basin (Silvertip, Marmot, Chickaree) show evidence of a high gopher population. Without control, planting in these areas will likely be unsuccessful. The need for control efforts depends on management objectives, stocking levels, and pocket gopher activity levels. Gopher activity, determined by mound surveys (see Animal Damage Control Handbook, FSH 2609.22), on 25 percent or more of the plots would indicate sufficient activity to adversely impact forest regeneration. Three tactics are available for controlling gopher populations.

a. Direct control. The most effective method of reducing or preventing damage is direct reduction of pocket gopher numbers. Because trapping is time consuming, it is practical only on small areas or as a supplement to other forms of control. Baiting with strychnine-treated grain is the most practical method in forest situations. Control projects are most effective when there is fresh mount-building activity and when soil moisture is adequate to prevent collapse of the burrows. These conditions usually occur during late fall and early spring. The recommended procedure is to control gophers in the fall prior to planting, with a follow-up treatment in early spring to pick up residual animals.

b. Habitat manipulation. Control of grasses and forbs can improve seedling survival by preventing population increases or by making habitats less suitable. Grass and forb control also reduces vegetative competition. This approach will not eliminate problems, but may improve the effectiveness of direct control.

c. Physical barriers. "Vexar" seedling protectors around shoots and roots of seedlings have provided short-term protection. Long-term efficacy is still unknown. This approach is most effective when integrated with other control methods.

7. Integrate Treatments. Management alternatives 2 through 6 are not mutually exclusive; they can be used alone or in combination in various parts of the Lake Alpine Basin to produce the results desired by the resource manager. Consideration of the interactions among all insect and disease problems present in the area during the development and implementation of a vegetation management plan will result in successful integration of pest management strategies, and best meet the stated objective.

APPENDIX

SITE-SPECIFIC OBSERVATIONS

Silver Valley Campground

A. Fomes annosus conks in red fir stumps:
   1) at unit 1, on both sides of the road at unit 5, across the road from units 9 and 11, and at unit 21

   2) dead red fir saplings adjacent to infested stump at unit 11

B. Red fir dwarf mistletoe:
   on decadent overstory trees in the area of unit 7

C. Western gall rust:
   on lodgepole pine saplings at campground entrance

D. Yellow witches broom:
   on one red fir sapling at unit 7

E. Mountain pine beetle:
   associated with dead sawtimber-sized lodgepole pines at units 7 and 16

F. Flooding:
   no pests associated with dead and dying red firs behind unit 11; evidence of man-made change in drainage pattern suggests lack of oxygen in root zone as cause

Pine Marten Campground

A. Fomes annosus conks in red fir stumps:
   1) behind unit 2, in the vicinity of units 6 and 7, at units 11 and 13, and in the general area of units 24 and 25

   2) dense red fir saplings adjacent to infested stumps at units 2, 6, 7 and 13

B. Red fir dwarf mistletoe:
   1) present on overstory trees throughout the campground

   2) on understory trees in the area of unit 15

C. Red ring rot:
   on decadent red firs at units 1 and 2

D. Mountain pine beetle:
   attacks associated with dead overstory lodgepole pines at unit 2

E. Overstocking:
dense (over 300 sq.ft./acre basal area) red fir saplings between units 4 and 6; between units 6 and 7; at units 7, 8, 14, 19; and in the area of units 23, 24, and 25

Backpackers Campground

A. Conks of *F. annosus* present in most red fir stumps

B. Yellow witches broom on one pole-sized lodgepole pine

C. Western gall rust common on lodgepole pines along stream

Lake Alpine Campground

A. *Fomes annosus* conks in red fir stumps:
at units 6, 7, 8, 13, 23, and 25

B. Red fir dwarf mistletoe:
on overstory trees in the area of unit 10

C. Western gall rust:
branch galls on one lodgepole pine at unit 3

D. Fir engraver:
common on dead as well as living red fir poles and sawtimber at units 7, 10, and 19

E. Potentially hazardous trees:
lodgepole pine with basal wound and associated decay at unit 8; dead overstory lodgepole pine with mountain pine beetle attacks at host trailer; and dead 90 ft. tall red fir at unit 9

Silvertip Campground

A. *Fomes annosus* in red fir stumps:
in stand opening behind unit 1, between units 1 and 2, at units 12 and 13, and across the road from unit 18

B. Red fir dwarf mistletoe:
1) on decadent overstory trees throughout the campground; Cytospora canker associated with infected branches

2) not noted in understory

C. Western gall rust:
bole cankers on lodgepole pines at unit 7

D. Yellow witches broom:
on one red fir behind unit 10, and one red fir at unit 11

E. Mountain pine beetle:
associated with dead overstory lodgepole pine at unit 8

F. Gophers:
signs of activity in meadow across from unit 19

G. Overstocking:
dense lodgepole pine and red fir saplings and poles between unit 7 and restroom; and across from unit 12

H. Potentially hazardous trees:
red firs with broken and dead tops at campground entrance; from snow damage

Marmot Picnic Area

A. Fomes annosus conks in red fir stumps:
present throughout the picnic area

B. Red fir dwarf mistletoe:
on overstory trees in vicinity of restroom

C. Lodgepole pine dwarf mistletoe:
on scattered overstory trees throughout

D. Atropellis canker:
stem cankers noted on three lodgepole pines

E. Yellow witches broom:
on four red fir trees scattered throughout area

F. Fir engraver:
attacks on living pole-sized red firs in areas of overstocking

G. Gophers:
activity in stand opening near amphitheater

Chickaree Picnic Area

A. Red fir dwarf mistletoe:
on most overstory trees

B. Western gall rust:
stem cankers common on lodgepole pines at eastern end of picnic area

C. Lodgepole pine needle cast:
causing defoliation of second year and older needles on saplings and poles adjacent to Alpine Lake

D. Pine engraver:
attack of tops of pole-sized lodgepole pines bend over by snow

E. Gophers:
girdled lodgepole pine seedlings at eastern end of picnic area

APPENDIX

BIOLOGY OF PEST ORGANISMS

Following are summaries of the biologies of pests causing mortality or damage in the Lake Alpine Basin.

Annosus Root Disease (Fomes annosus). Fomes annosus is a fungus that attacks a wide range of woody plants, causing a decay of the roots and lower bole and death of sapwood and cambium. All conifer species in California are susceptible to the fungus. Hardwood species are rarely damaged or killed. Infected pines are usually killed rather rapidly when the fungus girdles the root collar. In contrast, older true firs can survive infection for many years, although butt and root rot may become extensive, resulting in tree weakening and windthrow.

During periods favorable to the fungus, fruiting bodies form in decayed stumps, under the bark of dead trees, or in the duff at the root collar. The fungus becomes established in freshly cut stumps from air-borne spores produced by the conks, and then grows into the root system. True firs can also be infected by spores invading fresh basal wounds. The fungus then spreads to healthy roots of surrounding susceptible conifers via root contacts. In general, infections will cross from pine to true fir; however, rarely is the fungus observed to cross from true fir to pine. Local spread of the fungus outward from a stump typically results in the formation of disease centers, with dead trees in the center and fading trees on the margin. These centers usually continue to enlarge until they reach barriers such as openings in the stand or groups of non-susceptible plants.

The fungus may remain alive for as long as 50 years as a saprophyte in infected roots and stumps. Young susceptible tree species often become infected and die after their roots contact old infected root systems in the soil.

Dwarf Mistletoes. Red fir (A. abietinum f.sp. magnificae); lodgepole pine (A. americanum): Red fir is the only host for red fir dwarf mistletoe, just as lodgepole pine dwarf mistletoe infects only lodgepole pine. Other conifers are rarely infected and hardwoods are immune to these pathogens. The pathogens are obligate parasites obtaining their nutrients, minerals and water from the host.

These parasites are dioecious, perennial higher plants that produce seeds as their means of spread. In the fall of the year when the fruit falls from the stem, the seed is ejected upward and outward. The seed adheres to any surface it contacts. When the seed lands in the crown of a susceptible host tree, it adheres to a needle or limb and overwinters. The following spring it germinates and penetrates the limb. For the next 2 to 4 years the plant grows in the tree limb, developing a root-like endophytic system in the inner bark and outer sapwood. It then produces aerial shoots and in another 2 to 4 years produces reproductive structures.

Spread of dwarf mistletoe is limited to the distance traveled by the seed, which from overstory to understory is usually 20 to 60 feet, but may be as much as 100 feet if wind assists the seeds. As a rule of thumb, dwarf mistletoe can spread horizontally to the understory a distance equal to the height of the infection in the overstory tree. Because of the various limits to spread, such as height of the source plant, angle of discharge, wind velocity, stand density, etc., the actual spread rate through an even-aged stand is about 1 to 2 feet per year.

Western Gall Rust (Endocronartium harknessii). Western gall rust causes branch galls and trunk cankers on nearly all species of hard pines. The rust fungus produces yellow to orange-colored spores (aeciospores) on the surface of the galls during cool, moist, spring weather. The spores are wind disseminated and can infect other pines directly. Invasion of the cambium through the pine bark by the rust fungus results in the formation of woody galls. Galls on branches are typically spindle-shaped. The galls continue to enlarge and produce new spores each spring until they have girdled and killed the branch or stem. Girdling of branches results in a reduction of tree growth. Trunk cankers deform and reduce the strength of the bole.

Lodgepole Pine Needle Cast (Davisomycella montana). This disease commonly occurs on lodgepole pine in the Sierra Nevada, but does not cause much damage to its host except in localized areas. This needle cast is characterized by the appearance of shiny, black, elliptical fruiting bodies found in groups on dead areas on 2-year-old needles. The dead areas are usually separated from green tissues by an orange-brown band. Spores produced in the fruiting bodies probably infect 2-year-old or older needles. Infection causes browning of needles and defoliation. Heavy defoliation will reduce tree growth, but will seldom kill trees. Many of the needle cast fungi infect only trees weakened by unfavorable environmental factors.

Pine Engraver Beetle (Ips spp.). Pine engravers breed most frequently either in the tops of live pine trees or in fresh green slash. Attacks on live trees are usually limited to trees which are suppressed, or stressed by dwarf mistletoe, root disease, drought, fire, or the attack of other insects. If fresh slash is available in the spring, the pine engravers may build up in an area and cause locally heavy top killing by mid-summer. Attacks are made with the coming of warm weather in the spring. A new generation is produced in 6-8 weeks in the spring, to 4-6 weeks in mid-summer (August). Thus, several overlapping generations per year may be produced. The winter may be passed in any of the life stages of larvae, pupae, or adults, depending upon species involved.

Outbreaks in standing, healthy trees are sporadic and of short duration, and are often associated with some temporary stress or shock afflicting the host species, such as severe competition or sudden opening of the stand. Tree killing frequently occurs where green pine slash, which serves as breeding habitat, is left untreated during spring and summer.

Fir Engraver (Scolytus ventralis). The fir engraver attacks most true firs in western North America. Attacks can result in mortality, top-kill, or patch kill along the bole in firs ranging from large saplings to old-growth. Mortality and top-kill frequently are associated with stress induced by overstocking, drought, root disease, soil compaction, excessive and sudden exposure, heavy dwarf mistletoe infections, and other factors limiting tree health and vigor. Because of the sporadic occurrence of widespread, severe mortality and top-kill and the prevalence of healthy broods in living trees (patch attacks), direct control measures are generally impractical. A healthy vigorously growing stand is the best means of minimizing damage from fir engravers.

Adults fly and attack trees or green fir slash between June and September; larvae, pupae, and adults overwinter under the bark of infested trees. The life cycle takes one year, rarely two. Pitch tubes are not formed as with pine bark beetles, but unsuccessful attacks often are characterized by pitch streamers on the mid- and upper-bole. Low elevation trees successfully attacked early in the summer may exhibit fading of the foliage by early fall, but those attacked later in the year will not begin to fade until the following spring or summer. The beetles may have emerged by the time the tree fades.

Several other species of Scolytus, along with Pseudohylesinus, may be associated with the fir engraver. These contribute to the damage, as does the roundheaded fir borer, Tetropium abietis, which is also a frequent associate.

Pocket Gopher (Thomomys bottae). Pocket gophers live in closed burrow systems and spend most of their time below ground. The crescent-shaped mounds and plugged burrow entrances are major signs of gopher presence and activity. These animals are solitary except during the breeding season when young are being raised. Pocket gophers eat succulent underground parts of plants, although they may graze above ground on plants near burrow openings. Breeding occurs in early spring when green forage is plentiful, and litters of 4 to 8 young are born after a gestation period of 18 to 19 days. An annual turnover of more than 75 percent of the population is common. Young disperse, usually above ground, in late summer. Mound-building activity is most common during the late summer or early fall when young are dispersing and establishing their own burrows and adults are enlarging their systems in preparation for winter. Pocket gophers are active year round and even burrow through snow. Where preferred forbs and grasses are lacking, pocket gophers may feed on the roots of large trees.

Mountain Pine Beetle (Dendroctonus ponderosae). Lodgepole and western white pines are the principal hosts of the mountain pine beetle in the Lake Alpine area. Sugar and ponderosa pines are also hosts elsewhere. The beetle attacks only living trees larger than about 4 to 5 inches dbh. Under normal conditions, attacks are most successful in trees that have been stressed by dwarf mistletoe, overstocking or fluctuating water tables. The beetle has an aggregating pheromone which can attract additional beetles toward the site of a tree under successful attack. This may result in a group of trees being killed.

There would generally be one generation per year of the mountain pine beetle at Lake Alpine. Although attacks occur during the summer, the trees often do not fade until the following spring.

Mortality can be kept low in stands of host tree species by measures which maintain host vigor. These would include thinning, disease control and replacement of the stands before they become decadent. High value trees, such as in a recreation area, can be protected for a period of a year by applying insecticide to the bole if the tree is undergoing a reversable stress such as drought.